SIBAROPSIS (BRASSICACEAE), A NEW MONOTYPIC GENUS FROM SOUTHERN CALIFORNIA

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Abstract

A recently discovered annual crucifer is the sole representative of a new genus, *Sibaropsis*. The taxon is currently known from three mountains in the Peninsular Ranges of Southern California with a disjunction of ca. 120 km between the northern and southern populations. Potential affinities with *Streptanthus* sensu lato are considered, but the true relationships of the new genus remain cryptic. *Sibaropsis* is readily distinguished from other genera by a suite of characters which includes narrowly linear cotyledons and leaves, slightly zygomorphic corollas with petal claws forming a pseudotube and laminae apically notched, three-ranked staminal configuration with the adaxial filaments partially to wholly united into a nonpetaloid staminode, oblong-ovate anthers, tardily dehiscent siliques with a beak-like style, and a disarticulating infructescence rachis. The currently known populations are restricted to sunny, low-competition, vernally saturated clay soil microhabitats, generally in association with islands of *Stipa pulchra* grassland surrounded by chaparral.

Recent floristic fieldwork in the Peninsular Ranges of Southern California has resulted in three independent discoveries of a previously undescribed annual mustard. The first known collections were ours in the spring of 1992, and were made on Elsinore Peak in the Santa Ana Mountains in southwestern Riverside County. On its discovery, it was evident that this plant was new to the local flora. After extensive literature and herbarium searches, and verification that the plant did not constitute a rare introduction, we initiated work on describing this new taxon.

In the spring of 1993, we became aware that a perplexing annual mustard had been collected that season on Poser and Viejas mountains in the southern portion of the Cuyamaca Range of San Diego County by two botanists working independently of each other. Examination of these specimens confirmed that they represented the same taxon as had been collected the previous year in the Santa Ana Mountains (Fig. 1).

While it is clear that these plants constitute a distinctive but undescribed species, determination of the proper generic placement has proven considerably more difficult. The staminal arrangement suggests affinities with *Streptanthus*, particularly members of subgenus *Euklisia*. However, other staminal, floral, and vegetative features suggest potential relationships, albeit more distant, with *Streptanthella* or the Pacific Southwestern species of *Sibara*. Taken in their
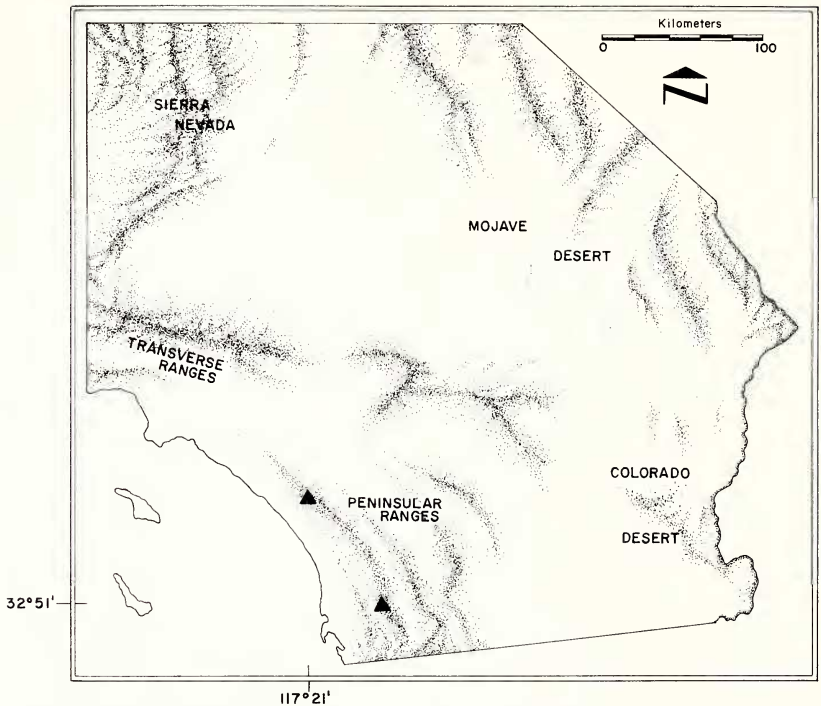
FIG. 1.   Map of Southern California illustrating the disjunction between the currently known northern and southern populations of *Sibaropsis*.

entirety, however, the unique suite of morphological characters exhibited by this new species prevent its ready placement within any currently recognized genus without considerable revision and blurring of traditional generic delimitations. Consequently, pending the major revisionary work that is likely to follow in the wake of extensive molecular studies currently underway in the family (R. Price, S. O'Kane, G. Allan, and M. Porter unpublished data), we find this species best accomodated in a new genus, which we here propose.

Sibaropsis hammittii S. Boyd & T. S. Ross, gen. et sp. nov. (Fig. 2). --Type: USA, California, Riverside County, Santa Ana Mountains, Elsinore Peak area south of Lake Elsinore, on "Onion Hill," a grassy knoll about 0.5 mile southeast of Elsinore Peak on the crest of the range, north of the Main Divide Road, T6S R4W SE¼ SW¼ sec. 31 (USGS Wildomar 7.5′ quadrangle), elev. 3320 ft, 1 April 1992, Boyd & Ross 6783 (holotype, RSA; isotypes, CAS, GH, MO).

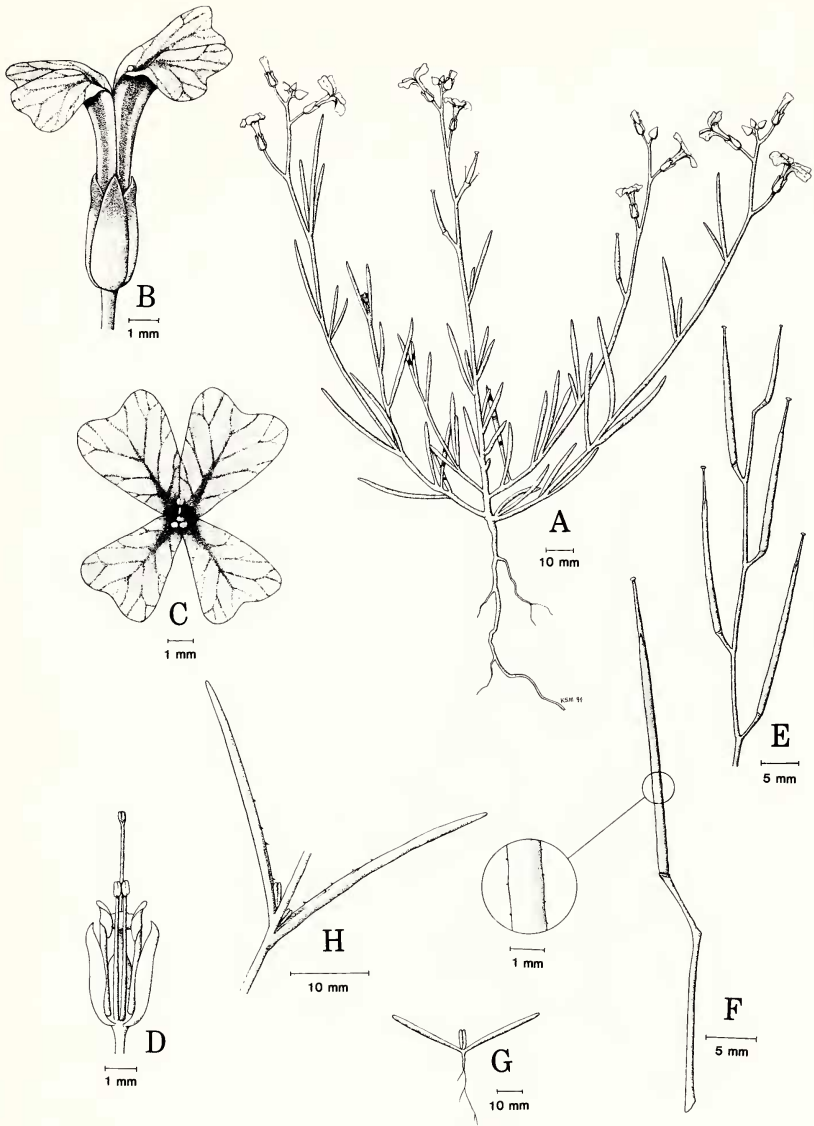Herba annua, fugax, tenella, simplex vel prope basin ramifera.

FIG. 2.   *Sibaropsis hammittii* S. Boyd & T. S. Ross. A) general habit; B) lateral view of calyx and corolla with exserted pseudotube formed by the slightly imbricate margins of the petal claws; C) frontal view of corolla showing slightly zygomorphic aspect; D) abaxial view of flower (petals and abaxial sepal removed) to show three-ranked staminal configuration and dimensions of gynoecium at anthesis; E) portion of infructescence illustrating general aspect; F) disseminule consisting of a silique, its pedicel, and the subtending length of the infructescence axis (inset—microscopic trichomes present on the silique margins and beak-like style); G) cotyledons and incipient true leaves; H) lower leaves with sparse, evanescent, ciliar trichomes.

Cotyledones ad folia vera amplitudo forma et textura similes. Rami
teretes ascendentes 5–15(–20) cm longi, glabri et leniter glauci. Fo-
lia anguste linearia, sessilia et non auriculata, (10–)15–30(–45) mm
longa, 0.5–1.0 mm lata, subviridia et parum glauca, praeter folia
infima ciliis paucis evanidis glabra, subsucculenta semiteretiaque,
apicibus acutis subrotundatis stramineis. Folia plus minusve erecta
vel ascendentia, subopposita necnon minime caespitosa ad primos
2–3 nodos (vero non rosulata), autem prompte alternascentia et dis-
sita supra basin. Inflorescentia ebracteata, racemosa, floribus paucis
dissitis (minus quam 10 generaliter). Internodia racemi longitudine
pedicellos superantes. Pedicelli ca. 0.5 mm diametro, 2–4 mm longi
sub anthesi, 3–4 mm longi ubi maturi, apicibus non amplificatis
manifeste. Calyx fere cylindricus (non urceolatus). Sepala subae-
qualia, erecta, discreta, glabra, oblonga-lanceolata vel oblonga-ova-
ta, ca. 3 mm longa, 0.5–1.0 mm lata, apicibus acutis et aliquando
apiculatis minute, lateralia leniter subsaccata ad bases. Corolla vulgo
zygomorpha, limbo bene evoluto, et pseudotubo per unguices exser-
tos parum imbricatos formato. Petala imbricata (uno exteriore et
quarto interiore), unguiculata-spatulata, 8.5–10.0 mm longa, expansa
ad ca. 4.5–5.0 mm, apicibus laminarum 2.0–2.5 mm latis, incisuratis
late non profunde, lobis deltoideis acutis rotundatis, subrosea-lavan-
dula vel sublavandula-purpurea venationibus purpureis. Utrumque
petalum adaxiale appendice basali parvula (nectarifera credimus) in
basim sepali lateralis contigui insertam. Stamina in tres series in-
aequales disposita. Stamina fertilia 4, abaxialia et lateralia. Filamen-
ta glabra antherae oblongae-ovatae ferentia. Filamenta lateralia ca.
2 mm longa antheris ca. 0.8 mm longis, et abaxialia ca. 3 mm longa,
libera vel raro connata, antheris ca. 0.5 mm longis. Filamenta adax-
ialia omnino vel maximam partem connata (in specie variat eti-
amque in eodem individuo), ca. 4.5–5 mm longa, in staminodium
subteretum non petaloideum parum exsertum modificata. Antherae
staminodii vestigiales, marcidae, ca. 0.2 mm longae, contiguae vel
leniter separatae. Ovarium sub anthesi ca. 2.0 mm longum, 0.5–0.7
mm latum, stylo angustior ca. 0.2 mm longo, stigmatem discoideum
ferente. Siliqua suberecta, anguste linearis, satis compressa, (15–)
20–25 mm longa, 0.6–0.8 mm lata, stylo persistente tenui subros-
tellato (1.5–)3.0–4.5 mm longo, praeter trichomata microscopica
marginales glabra, foliis positione amplitudone ambitu et colori sim-
ilis, maxime tarde dehiscens. Infructescentia ubi matura in segmenta
frangens, unumquidque siliqua pedicello et parte infructescentiae
rhachidis capientia. Sementes 1-seriata, non mucosa, oblonga, com-
pressa, plus minusve truncata obtusiuscule ad hilum, rotundata et
non nisi microscopicaliter alata ad extremum distale, paginis minute
striatis vel grosse scalpratis. Cotyledones incumbentes.

Delicate, short-lived, cool season *annual*, freely branched at and

near the base. *Cotyledons* narrowly linear, attaining similar size, shape, and texture to the true leaves. *Axillary buds* of the cotyledons occasionally developing (in the absence of apical damage), but generally later than those of the lowermost true leaves. *Branches* terete, ascending, 5–15(–20) cm long, glabrous and slightly glaucous, light green but often with a faint purplish suffusion or mottling, especially above. *Leaves* narrowly linear, sessile and lacking auricles, (10–) 15–30(–45) mm long, 0.5–1.0 mm wide, light green and slightly glaucous, glabrous except for a few scattered, evanescent cilia on those of the lowest nodes (poorly developed or absent in depauperate plants); somewhat fleshy and semi-terete, the adaxial surface slightly flattened, the abaxial surface rounded; apex acute, slightly rounded, yellowish. True basal rosette lacking, the cotyledons and leaves of the first two to three nodes initially tufted prior to elongation of the internodes. Leaves ± erect-ascending, opposite at the first 1–2(–3) nodes of the main axis and lowermost branches, becoming alternate above, uncongested. *Inflorescence* ebracteate, loosely racemose, relatively few flowered (mostly fewer than 10). Flower buds initially crowded, raceme internodes elongating at and after anthesis, becoming longer than the pedicels. *Pedicels* slender, ca. 0.5 mm diameter, 2–4 mm long at anthesis, 3–4 mm in fruit, not markedly expanded at their apices. *Calyx* tubular, glabrous. The four *sepals* subequal, erect, free to their bases, purplish to greenish purple with paler bases and narrow whitish bands on their margins, oblong-lanceolate to oblong-ovate, ca. 3 mm long, 0.5–1.0 mm wide; the apex acute, sometimes minutely apiculate, the lateral sepals only very slightly saccate at their bases. *Corolla* slightly zygomorphic with a well-developed limb and a pseudotube formed by the slightly imbricate margins of the well-exserted petal claws. The four *petals* unguiculate-spatulate, 8.5–10.0 mm long, spreading at ca. 4.5–5.0 mm; the apex 2.0–2.5 mm wide, shallowly and broadly notched, the deltoid lobes acute, rounded; light purplish-lavender or pinkish-lavender with darker purplish veins, aging to a more saturated purplish prior to withering. Upper petals with a small basal appendage (presumably nectariferous) directed into the base of the adjacent lateral sepal lobe. *Stamens* arranged in three unequal series. Fertile stamens 4, lateral and abaxial in position, the filaments glabrous, mostly pale yellowish-white except at the tip where purplish, bearing oblong-ovate anthers; the lateral pair of filaments ca. 2 mm long, with stamens ca. 0.8 mm long; the abaxial pair longer and closely juxtaposed but usually free (uncommonly connate), ca. 3 mm long, with anthers ca. 0.5 mm. Abaxial stamens maturing before the lateral. Pollen pale yellow. Filaments of adaxial stamen pair partly to wholly connate, ca. 4.5–5.0 mm long, modified into a *staminode* slightly exserted from the mouth of the corolla; upper ½ to ⅔ dark purple, paler below. Sterile anther sacs of the staminode vestigial,

reduced to whitish, wrinkled structures ca. 0.2 mm long, mostly closely placed, but occasionally slightly separated on the bifurcate staminode tip; bifurcation 0–2.0 mm deep, variable even within individuals. *Ovary* at anthesis oblong, ca. 2.0 mm long, 0.5–0.7 mm wide; style narrower, ca. 0.2 mm long, bearing an unlobed, discoid stigma which slightly exceeds the style diameter. *Fruit* a tardily dehiscent silique, suberect, narrowly linear and somewhat flattened parallel to the septum, (15–)20–25 mm long, 0.6–0.8 mm wide, with a slender, persistent, moderately beak-like style (1.5–)3.0–4.5 mm long; glabrous except for scattered, clear, simple microscopic hairs along the lateral sutures and stylar beak; similar to the leaves in orientation, size, shape, and color (when immature). At maturity, leaves wither and fall away leaving the branch architecture and ascending siliques, which dry to a light tan or chestnut brown color. *Infructescence* ultimately disarticulating at abscission zones along the central axis, just above each pedicel, the functional dispersal unit then comprising a silique with its pedicel and a length of the infructescence axis. The exception to this pattern is the lowest silique of each flowering branch, which remains attached to the dried plant base. *Seeds* uniseriate, non-muscilaginous, oblong, ca. 1.2 mm long, 0.5 mm wide, reddish-brown to dark olive-brown with minutely striate or chiseled surfaces, laterally flattened, ± truncate at the pylar end (sometimes obliquely so), rounded and only microscopically winged distally (Fig. 3). Cotyledons incumbent. Chromosomes: 2n=28.

Paratypes. USA, California, Riverside County, Santa Ana Mountains, clay soil areas on Elsinore Peak, T6S R4W SW¼ sec. 31 (USGS Wildomar 7.5′ quadrangle), elev. 3320–3360 ft, 31 March 1992, Boyd & Ross 6771, (RSA, F, K, MEXU, NY, SD, UC, UCR, US); San Diego County, Viejas Mountain, on Forest Service land ca. 1 mile northeast of intersection of Viejas Grade and Willow Road (directly above 19520 Viejas Grade), 25 March 1993, Hirshberg 197 (SD); Poser Mountain, 0.7 mile east of intersection of Red Oak Road and Viejas Grade, east side of road, 6 April 1993, Reiser s.n. (SD).

Etymology. The generic name (*Sibara*, anagram of *Arabis*, coined by E. L. Greene; and *opsis* [Greek], resembling in appearance) alludes to the general floral similarity of the taxon to the *Sibara* species of the Pacific Southwest. The specific epithet honors our colleague and esteemed friend, Mike Hammitt (1957–1991), an enthusiastic Southern California naturalist whose untimely death cut short a very promising life of discovery. Because common names are frequently considered desirable for the lay-person, we propose "Hammitt's clay-cress" as the vernacular for this rare species.
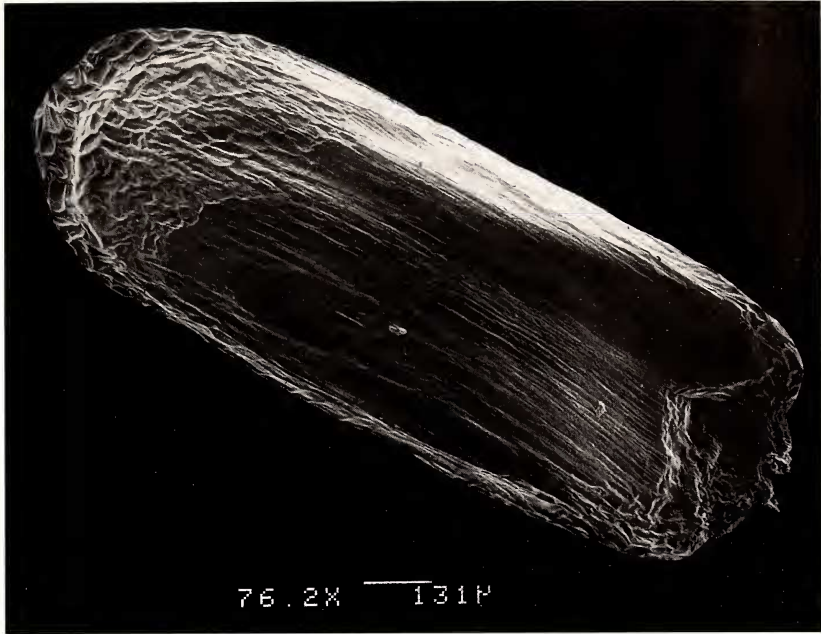
FIG. 3.   Scanning electron micrograph of a representative seed of *Sibaropsis ham-mittii* illustrating the striate or partially chiselled seed coat pattern, and the vestigial, microscopic wing at the distal end.

POTENTIAL TAXONOMIC AFFINITIES

The Brassicaceae, while one of the better marked and natural flowering plant families, is notable for the considerable difficulties encountered in delimiting its component genera (Al-Shehbaz 1973). It is widely accepted that generic boundaries in the family are often arbitrarily drawn, confounding efforts to understand natural lineages and intergeneric relationships (Al-Shehbaz 1984). Examples in which two or more genera exhibit morphological overlap are so numerous in the family as to be almost the rule, rather than the exception (Rollins 1982). As a result, the family is characterized by a remarkably high percentage of oligotypic genera: 40% monotypic, with an additional 33% represented by 5 or fewer species (Al-Shehbaz 1984).

Against this backdrop of often tenuous supraspecific entities, de-termining the appropriate generic placement for *Sibaropsis hammit-tii* has proven a difficult task. Shortly after its original discovery in 1992, during which time we sought to establish whether the species was native or introduced, we investigated potential affinities of *Si-baropsis* with several genera primarily from North America, Eurasia, and northern Africa. Based on the literature, various genera showed

potential morphological similarities, among them the Mediterranean *Moricandia*, *Malcolmia*, *Chorispora*, and the Central Asian *Dontostemon*. Surveys of the known species in these and other genera consistently resulted in dead-ends, and incrementally excluded the possibility that the new taxon was a rare introduction from another arid region of the world. After confirming its native status to the degree possible, we began to focus more closely on its potential relationships with other North American taxa. The unusual staminal configuration in *Sibaropsis*, if made the exclusive focal point of taxonomic comparison, would suggest potential generic placement in the genus *Streptanthus*.

This genus, as treated by Rollins (1993), consists of 33 species occurring in the western and southwestern United States as well as northern Mexico. It is taxonomically associated with several other genera whose true relationships remain problematic. *Caulanthus*, a western North American genus of ca. 13–16 species, and *Stanfordia*, a monotypic genus of south-central and western California (Rollins 1993), have been treated tentatively by Rodman et al. (1981) in an expanded concept of *Streptanthus*. Under this broader circumscription, which we will discuss here as "*Streptanthus* sensu lato," the genus consists of about 50 species parceled among five subgenera, and includes annual, biennial, and perennial herbs (Rodman et al. 1981; Al-Shehbaz 1985). Its greatest species diversity is found in California, where many species are edaphic endemics, particularly on serpentine or other ultramafic substrates (Buck et al. 1993; Rollins 1993). Traditionally placed within the tribe Thelypodieae, the genus is united by a diagnostic floral morphology which includes zygomorphic calyx and/or corolla, and three-ranked stamens, the longest set often (but not always) with fused filaments and reduced anthers (Schulz 1936; Rollins 1993).

The slightly zygomorphic corolla and three-ranked staminal configuration of *Sibaropsis*, particularly the modification of the longest set into a staminode, provides the most compelling argument for inferring a close relationship with *Streptanthus*, in which this staminal configuration is otherwise considered unique. If *Sibaropsis* were treated as a *Streptanthus*, its possession of a staminode would likely require that it be placed within subg. *Euklisia*, a group which includes annuals and biennials and is distributed from central cismontane California northward to extreme southwestern Oregon (Hoffman 1952; Buck et al. 1993). Alternately, its anomalous characters might suggest its treatment as a monotypic subgenus within *Streptanthus*.

There are, however, some important differences between *Streptanthus* and *Sibaropsis* with respect to the shared staminodial structure and general anther morphology. In *Streptanthus* subg. *Euklisia*, the fused filaments are relatively broad and petaloid and, in most

species, the vascular traces of the filaments are readily visible and clearly separate. In *Sibaropsis*, the staminodial filament is narrow, more or less terete, and without readily visible paired vascular traces. In *Streptanthus*, the fertile anthers, as well as the reduced anthers of the staminode, are essentially the same shape: linear-sagittate with an acute apex. In *Sibaropsis*, however, the fertile anthers are oblong-ovate with a rounded apex, and the reduced anther sacs of the staminode are small and shriveled, retaining no particular shape.

The flowers of *Streptanthus* may be zygomorphic or actinomorphic. Unlike the tubular, essentially actinomorphic calyx of *Sibaropsis*, with its small, erect lobes of fairly uniform size and shape, the calyces of most *Streptanthus* species are relatively large, and frequently inflated or flask-shaped. This is particularly true of those in the subg. *Euklisia*, reaching an extreme in *S. polygaloides* A. Gray. Petal morphology, as with other characters, varies considerably within *Streptanthus* sensu lato. In the subg. *Euklisia* the petals typically have a broad claw and a narrow, crisped blade without an apical notch. These are in contrast to the petals of *Sibaropsis*, which have a narrow claw that broadens rather abruptly into the apically notched, expanded lamina.

Another morphological character worth considering in *Sibaropsis* is the elongate, persistent, beak-like style. Although no ovarial tissue occurs within it, and it can by no means be considered a true "beak" as the term is generally applied in the crucifers, its presence and form clearly distinguish the taxon from *Streptanthus* sensu lato, in which the styles tend to be short and blunt, the stigmas in a few taxa being nearly sessile.

Seed morphology varies considerably within *Streptanthus* sensu lato, and the gross external features and size of *Sibaropsis* seeds would not necessarily be excluded from the range of variation evident in *Streptanthus* subg. *Euklisia*. It is of interest, nevertheless, to consider cotyledon position here. Embryo configuration has often been given consideration in the Brassicaceae due to its uniformity in many groups. Unfortunately, it may also be variable within genera, leading some students of the family to discount its value as a taxonomic character (Murley 1951). Within *Streptanthus* sensu lato, where cotyledon position is somewhat variable, it may be accumbent or obliquely accumbent (*Streptanthus* sensu stricto, *Caulanthus* pro parte), obliquely incumbent (*Caulanthus* pro parte), or coiled (*Stanfordia*) (Rollins 1993). All species of *Streptanthus* subg. *Euklisia*, however, have seeds with accumbent cotyledons while those of *Sibaropsis* are incumbent.

Leaf morphology in *Streptanthus* is highly variable and may range from broadly ovate or obovate to linear-lanceolate. Likewise, the leaves may be petiolate or sessile (usually above), and may or may not be auriculate at their bases. The lowest leaves may be clustered

or not, but there is a notable tendency toward dimorphism between the basal and cauline leaves which is often quite dramatic. As with most crucifers, there is also a great morphological difference between the cotyledons and the true leaves. In contrast, there is remarkable uniformity in the leaves of *Sibaropsis*, from the narrowly-linear cotyledons, to the first true leaves, to the uppermost leaves subtending the racemes. No species of *Streptanthus* has leaves remotely approaching the narrowly linear, semiterete leaves of *Sibaropsis*.

In addition to these differences, none of the species of *Streptanthus* is recorded as having linear cotyledons. Certainly, none of the species has tardily dehiscent siliques, or disarticulating infructescence axes.

As has been noted, a putative alliance of *Sibaropsis* with *Streptanthus* rests very heavily on shared aspects of the highly modified staminal configuration, but does so to the exclusion of other important morphological characters. We have preferred to assess the organism in toto, and have not abandoned the possibility that such a morphological trait could have originated independently of *Streptanthus* through similar selective pressures of pollinators.

While this staminal arrangement is unusual in the family as a whole, and the particular combination has, until now, been considered unique to *Streptanthus*, the component elements of this character on an individual basis are neither unique to, nor universally present within the genus (Rollins 1993). For example, three-ranked stamens are also reported for the New World genus *Streptanthella* and the Old World *Camelina* (Schulz 1936; Rollins 1993), while fusion of the filaments of the adaxial paired stamens is found in both Old World genera (*Blenodia, Dontostemon, Euzomodendron, Orychophragmus*) and New (*Glaucocarpum* and *Thelypodium*) (Schulz 1936).

There are, of course, additional genera—and morphological characters—that could be brought into this discussion of potential affinities. In our assessment of *Sibaropsis* and its potential alliances, we have remained cognizant of the traditional weight placed on floral structure and fruit morphology, but have also tried to balance these with other morphological traits that equally characterize the taxon, and which may also be subject to adaptive pressures over geologic time, or random, advantageous mutations. With its overall suite of characters considered, *Sibaropsis* appears to be allied with such genera as *Streptanthus, Caulanthus,* and *Streptanthella* in the tribe Thelypodieae, as well as the Pacific Southwestern species of *Sibara*, which we feel are misplaced in their traditional alliance with the Arabideae.

In this context, the somatic chromosome count obtained for *Sibaropsis hammittii* is worth commenting on. The material counted
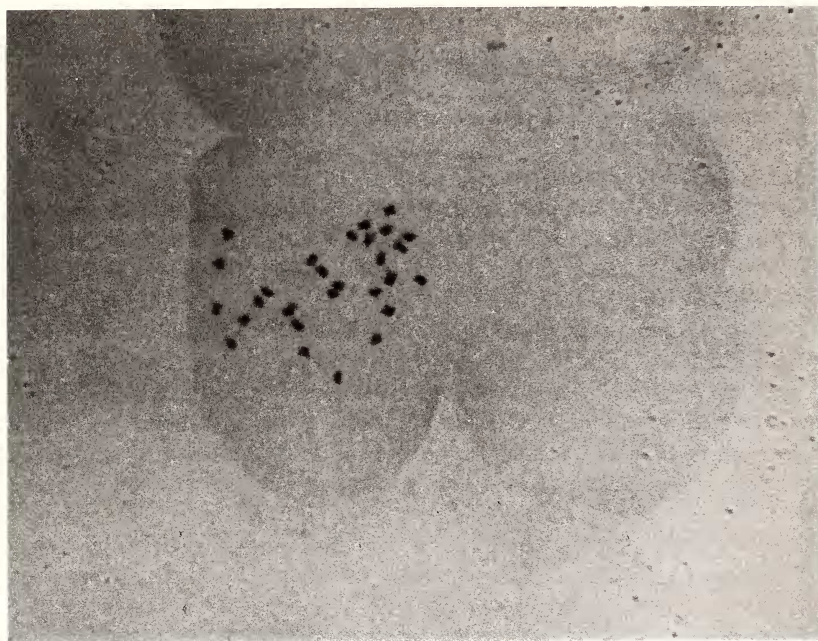
FIG. 4. Photograph of a root-tip chromosome preparation of *Sibaropsis hammittii* showing a somatic count of $2n=28$ [Cultivated voucher: S. Boyd 8203A (RSA)].

was derived from seeds of cultivated F_2 plants originating at the type locality. Root tip squashes were prepared following the protocol of Li (1982) and indicated a count of $2n=28$ (Fig. 4). Although this number is somewhat unusual in the family, it is typical of the monotypic *Streptanthella* and *Stanfordia*, most species in the genera *Caulanthus* and *Streptanthus*, as well as *Sibara angelorum* and *S. laxa* (counts for *S. brandegeana* and *S. filifolia* are not available) (R. Price personal communication; Rollins 1993). This may tend to suggest a close relationship among these lineages. However, extensive chromosomal studies have not yet been conducted throughout the Thelypodieae and counts are still unavailable for a majority of the taxa. Such wide gaps in the data preclude a clearer assessment of the overall chromosomal patterns in the tribe.

Having already addressed some of the attributes of *Streptanthus* sensu lato, discussion of the less obvious potential relationships to *Sibara* and *Streptanthella* is perhaps warranted here.

Sibara is a small North American genus traditionally considered most closely related to *Arabis*, in the tribe Arabideae (Rollins 1947, 1982, 1993; Al-Shehbaz 1988). Within *Sibara*, we informally recognize three phytogeographically and morphologically distinct assemblages which we refer to here as "the Virginica group" (4 spe-

cies), "the Deserti group" (2 species), and "the Angelorum group" (4 species). The first two groups we believe to represent more distant lineages and they will not be considered further here. The Angelorum group, however, approximates the generic concept established by E. L. Greene (1896) and is a seemingly more natural Pacific Southwestern assemblage of annuals comprised of *S. angelorum* (S. Watson) Greene, considered the type species by Greene [incl. *S. pectinata* (Greene) Greene]; *S. laxa* (S. Watson) Greene; *S. brandegeana* (Rose) Greene; and *S. filifolia* (Greene) Greene. The former three occur in the central deserts of Baja California, Mexico, although *S. angelorum* ranges farther northeast into Sonora state (Wiggins 1980). The last, *S. filifolia*, is an exceedingly rare insular endemic only known extant on the southerly extreme of San Clemente Island (Rollins 1947, 1993; Beauchamp 1987; Skinner & Pavlik 1994). It is this third suite of species (the Angelorum group) that we refer to as *Sibara* sensu stricto and which we compare to the new taxon.

Sibara sensu stricto possesses a few characters worth considering in relation to *Sibaropsis*, although there are also important morphological differences. Foremost in similarity are such characters as anther shape, seeds, and gross features of the leaves, calyx, and petals.

Surprisingly little information has been published on anther morphology of *Sibara* sensu stricto; however, it is apparent that Greene's (1896) characterization of the anthers as "linear-sagittate" is incomplete. Our examination of numerous dried specimens of *Sibara* housed at RSA-POM as well as fixed flowering material confirms the report by Al-Shehbaz (1988) that the anthers of *Sibara* may be oblong to ovate, as well as linear-sagittate. In relative size and shape, the fertile anthers of *Sibaropsis* closely resemble the anthers of *Sibara angelorum*.

In terms of seed morphology, both *Sibara* and *Sibaropsis* have seeds that are oblong and essentially wingless. In *Sibara*, cotyledon position is variable and may be accumbent (*S. angelorum*), or incumbent (*S. brandegeana* and *S. laxa*; obliquely so in *S. filifolia*) as are those of *Sibaropsis*.

As for more plastic features, the leaves of *Sibara* are glaucous and somewhat fleshy, and are pinnatifid or pectinate with linear rachises and narrowly-linear lobes. In depauperate plants there is a tendency toward reduction in the number of lobes and the upper cauline leaves are not uncommonly sessile, entire, and narrowly linear. Were the narrowly-linear leaves of *Sibaropsis* derived from a progenitor of similar morphology, one might hypothesize the fixation of such a character in a diminutive, short-lived species. Such adaptive changes in vegetative features are likely as easily attained

and genetically fixed as would be similarly dramatic changes in floral morphology that result in a new pollination syndrome.

The calyx of *Sibaropsis*, with its small, erect lobes of uniform size and shape, is essentially actinomorphic and quite similar to that of *Sibara*. In both genera, the lateral sepals are only very slightly saccate, and the calyx is entirely glabrous (Rollins 1993). Although there do appear to be general morphological trends within most cruciferous genera, little is known, unfortunately, of the selective pressures that may act on calyx morphology.

Also of great similarity, but undoubtedly subject to tremendous selective pressures of pollinators, are the size, shape, and coloration of the petals in both *Sibaropsis* and *Sibara*. Both occur in ± lavender shades with darker veins, and have narrow claws with broad, ± plane laminae which are apically notched. While such petals are relatively uncommon among crucifers in western North America, the characters are present in other quite unrelated genera, such as *Malcolmia* and *Leavenworthia*, and have clearly arisen on multiple occasions (Rollins 1993). An important structural difference between *Sibaropsis* and *Sibara* is that the corolla of the former bears a distinctive pseudotube exserted above the calyx, while the petals of the latter are spread at the summit of the sepals.

Among the more notable dissimilarities are the linear cotyledons of *Sibaropsis*, which gradually expand in size until they quite resemble the narrowly-linear true leaves. In contrast, the cotyledons of *Sibara* tend to be broadly ovate-elliptic and never approximate the morphology or size of the true leaves.

Additionally, the mature silique valves of *Sibara* are readily dehiscent, as is common in most crucifers, while the tardily dehiscent siliques of *Sibaropsis* apparently open only with age or weathering. In *Sibaropsis*, the disarticulation of the infructescence axis at abscission zones differs not only from *Sibara*, but appears to be unknown in any other crucifer. Perhaps the most similar case occurs in the genus *Warea* (Thelypodieae), with four species in the southeastern United States, in which the infructescence axis remains intact but the fruiting pedicels often abscise from the axis (Rollins 1993).

An important character that obviously differentiates *Sibaropsis* from *Sibara* is the staminal configuration. In *Sibara*, the stamens are consistently two-ranked (tetradynamous) with all anther sacs bearing fertile pollen, while the three-ranked staminal configuration in *Sibaropsis*, with the additional fusion of the adaxial pair into a staminode (Fig. 2D), presents an unusual architecture with unknown advantages but which is presumably associated with pollinator attraction and/or orientation. As with petal coloration and morphology, stamen length and connation are likely subject to similar selective pressures over geologic time, and are limited only by the genetic potential of the progenitor.

Another genus which does possess three-ranked stamens, but which otherwise might not be readily thought of as a potential ally to *Sibaropsis*, is *Streptanthella*. This is a somewhat variable but monotypic genus widely distributed in xeric portions of the American West, from Washington, Montana, and Idaho southward to New Mexico, Baja California, and Sonora, Mexico (Munz and Keck 1959; Rollins 1993). It is a glaucous, narrow-leaved annual of sandy to gravelly soils, and is particularly noted for its siliques with a beak-like, indehiscent tip ca. 3–4 mm long, for which it has received the epithet *S. longirostris* (S. Watson) Rydberg.

This beak-like silique tip is similar in form and dimension to that of *Sibaropsis*, and the indehiscent character of the distal portion of the fruit might lead one to hypothesize a relationship due to the intermediacy of the silique valve dehiscence. The cotyledons of *Streptanthella*, like *Sibaropsis*, are incumbent, although they may often be so in an oblique manner (Rollins 1993). In addition, *Streptanthella* is apparently unusual in the Thelypodieae in possessing linear cotyledons (R. Buck personal communication). The leaves of *Streptanthella* tend to be fairly narrow and with a definite bifacial lamina, but may be divided into linear lobes or be simple and ± linear above. As mentioned in the discussion of *Sibara*, one might envision the fixation of such a reduced, linear leaf morphology in *Sibaropsis* if it were potentially derived from a progenitor with similarly divided leaves. In the case of *Streptanthella*, however, in which the cotyledons themselves are linear, one might even hypothesize the retention of paedomorphic traits if additional lines of evidence suggested such a derivation.

Streptanthella, on the other hand, differs in a sufficient number of morphological traits that only a loose alliance can be postulated. While the calyx is similar to that of *Sibaropsis*, the lateral sepals are more distinctly saccate basally; the stamens, though three-ranked, are all fertile with free filaments, and bear linear-sagittate anthers; the petals are narrowly spatulate without an apical notch, not much surpassing the sepals, and range from white to pale yellow (often with purplish veins); and the seeds bear a narrow wing along their margins (Rollins 1993).

While it is clear that the morphological similarities between *Sibara* sensu stricto, *Streptanthella*, and *Sibaropsis* do not necessarily intimate a direct relationship, we believe that they are sufficiently enticing to merit careful exploration at the molecular level within the context of a broad-based phylogenetic study. Unfortunately, the Thelypodieae in western North America appear to be the result of a rapid and explosive radiation which obfuscates the true relationships of its parts and renders difficult an objective taxonomic scheme based on gross morphology.

Our efforts have focused largely on proper generic placement for

the new species and, failing that, on its possible generic relation-
ships. Based on current knowledge, however, we cannot yet surmise
what the sister taxon to *Sibaropsis hammittii* may be. It is clear that
an understanding of relationships in the Brassicaceae is hampered
by both the artificiality of many genera, and the dogmatic weighting
of certain characters to the exclusion of others. Future systematic
endeavor among the mustards will benefit from a more holistic ap-
proach to the species, micromorphological studies, and the careful
use of molecular techniques to divest the taxa of similarities result-
ing from convergence.

In the absence of a broad-based, highly inclusive molecular study
of the Brassicaceae, we find it most appropriate to propose generic
standing for this new species. The unique suite of morphological
characters found in *Sibaropsis*, specifically the narrowly linear cot-
yledons and leaves; zygomorphic, pseudotubular corolla; three-
ranked stamens with a subterete staminode; oblong-ovate anthers;
tardily dehiscent fruit with a beak-like style; and disarticulating in-
fructescence rachis; readily set the taxon apart from any other cur-
rently recognized crucifer genera.

HABITAT, LIFE HISTORY, AND CONSERVATION CONSIDERATIONS

At the original discovery site on Elsinore Peak, *Sibaropsis* occurs
on clay soils in grassland vegetation dominated by *Stipa pulchra* A.
Hitchc. in association with a rich assemblage of annual and peren-
nial herbs. These areas of *Stipa* grassland are fairly broad, with the
clay soil habitat present as discrete, island-like patches within a sur-
rounding matrix of taller-statured chaparral vegetation. This chap-
arral formation is largely dominated by *Adenostoma fasciculatum*
Hook. & Arn. and tends to occur on coarser soils which are locally
derived from granitics. On Elsinore Peak, which we refer to as the
northern population center, clay is derived primarily from local
weathering of Pleistocene basalt outcrops, and to a lesser extent,
Eocene marine sediments (Rogers 1965). These soils are mapped
locally as the Bosanko series (Knecht 1971). Species commonly
associated with *Sibaropsis hammittii* in this habitat include *Sisyrin-
chium bellum* S. Watson, *Lomatium dasycarpum* (Torrey & A. Gray)
J. Coulter & Rose, *Dichelostemma pulchellum* (Salisb.) Heller, *Sa-
nicula bipinnatifida* Hook., *Stipa lepida* A. Hitchc., *Allium haema-
tochiton* S. Watson, *Fritillaria biflora* Lindley, and *Corethrogyne
filaginifolia* (Hook. & Arn.) Nutt.

On Poser and Viejas mountains, *Sibaropsis* is also associated with
a *Stipa pulchra*-dominated vegetation type on disjunct islands of
clay soil surrounded by *Adenostoma* chaparral. However, both the
derivation of the clay and the physiognomy of the vegetation differ
from those at Elsinore Peak. At this southern population center, clay

is developed on colluvial deposits of basic intrusive gabbro (Cuy-
amaca Gabbro or San Marcos Gabbro) of Mesozoic age (Strand
1962). These soils are mapped as Auld clay (Bowman 1973). Al-
though the habitat is relatively open and includes the associated
species mentioned above, there is also a greater abundance of suf-
frutescent species and low shrubs, most notably *Salvia apiana* Jep-
son, *Eriogonum fasciculatum* Benth., *Eriophyllum confertiflorum*
(DC.) A. Gray, *Gutierrezia* sp., and *Artemisia californica* Less.
These tend to be scattered about the grassland and are generally
more compact than they usually appear in other habitats.

At both sites, however, *Sibaropsis* is not found throughout the
habitat, nor is it characteristically abundant. Instead, it is limited to
the most mesic microsites on fairly open soil in which the clay
substrate remains saturated with water throughout the winter and
early spring. Populations of *Sibaropsis* are relatively small in both
total number of individuals present and in areal extent. Generally,
the species may be found where it receives direct sun during the
day, and where water runs in thin sheets or rivulets, or seeps to the
surface, following the seasonal rains. Apparently critical to its es-
tablishment and successful growth is a constant supply of moisture
around the root system from germination through maturity, coupled
with low competition. At Elsinore Peak, for example, we have ob-
served small, sporadic populations on clay soil along the course of
a small surface rivulet, but at the margin of the clay outcrop where
it graded into granitic soils with better surface and subsurface drain-
age, the *Sibaropsis* plants were absent. The same observations were
made at Poser and Viejas mountains where the fine clay soils graded
into coarser soils. The fact that *Sibaropsis* is apparently limited to
distribution on clay soils is probably a result of the physical prop-
erties of the soil (expansive with high water-holding capacity), rather
than to a physiological requirement for, or tolerance of, a particular
element or micronutrient in the substrate. We have been able to
successfully cultivate the species on substrates other than clay, pro-
vided the substrate did not dry out until flowering and seed set were
complete.

Given the apparently narrow parameters of the microhabitat suc-
cessfully occupied by *Sibaropsis*, the seed dispersal mode seems
very well-suited to maintaining the species within an area suitable
for establishment and maturation. A fairly dynamic silique dehis-
cence would potentially waste a considerable number of seeds by
disseminating them into the adjacent chaparral. In contrast, the tar-
dily dehiscent siliques, and disarticulating infructescences, allow de-
position of the seeds largely in the immediate vicinity of the parent
plant. The actual disarticulation of the infructescence is probably
accomplished both by weathering effects and by mechanical damage
(wind, animals wandering across the grasslands, etc.). At maturity,

the siliques may generally only be opened with considerable phys-
ical manipulation. In cultivated plants, siliques have been observed
to remain intact throughout the summer and autumn, splitting open
only with the soaking of the first winter rains. It is possible, however,
that in the natural habitat some of the silique valves may open over
a shorter period of time with the effects of day-time heat and night-
time dews.

While the dispersal mode of *Sibaropsis* is appropriate for main-
taining it within its narrow habitat, that same dispersal mode makes
the major disjunction between the northern and southern population
centers quite perplexing. The populations at Elsinore Peak are sep-
arated from those of Poser and Viejas mountains by a linear distance
of over 120 km. Aside from the microhabitat parameters within the
Stipa grasslands, habitat correlations between the two population
centers are more difficult to establish. Based on the few populations
known, one might surmise that the species is restricted to the Pen-
insular Ranges of austral California. Other extrapolations can only
be of the coarsest kind at this point in time.

At the currently known localities, *Sibaropsis hammittii* is found
at moderate elevations in areas with direct access to the influx of
marine air. This cool, moisture-laden air is particularly prevalent
during the winter and spring and plays an important role in mod-
erating inland climate. On Elsinore Peak, the *Sibaropsis* populations
occur between 975 m and 1067 m, approximately 34 km inland from
the coast. The elevational range on Viejas and Poser mountains is
somewhat broader, 730 m to 975 m, with populations located 43 to
49 km inland from the ocean.

The Peninsular Ranges also harbor many other islands of Pleis-
tocene basalt and/or basic intrusive gabbro between both population
centers as well as southward. Many of these outcrops may bear
potential habitat that ought to be surveyed for the presence of *Si-
baropsis*. In all likelihood, future, appropriately-timed surveys of
these habitats will reveal the presence of additional populations. At-
tention should particularly be given to areas under coastal influence
and at elevations above 500 m. Among the localities meriting fo-
cused surveys are the higher gabbro and metavolcanic peaks of San
Diego County and adjacent northwestern Baja California, Mexico
(e.g., Otay, Tecate, San Miguel, Jamul, Cerro Bola, Cuyamaca,
McGinty, Guatay, Iron, and Agua Tibia), as well as the basaltic
Santa Rosa Plateau region of the Santa Ana Mountains.

The prospects for long-term preservation of the known popula-
tions of *Sibaropsis hammittii* seem encouraging. Both the northern
and southern population centers are situated primarily on public
lands administered by the Cleveland National Forest, although some
stands (or subpopulations) occur on privately-held and Indian Res-
ervation lands.

In both areas, *Sibaropsis* is closely associated with other sensitive plant species which are already receiving considerable management attention (*Allium munzii* [Ownbey ex Traub] D. McNeal at Elsinore Peak; *Acanthomintha ilicifolia* [A. Gray] A. Gray at Viejas and Poser mountains). The significance of the *Sibaropsis* populations should serve to increase attention toward the conservation needs of the sites, thereby increasing overall protection of these habitats and all taxa present.

The benefits of public land ownership to *Sibaropsis*, especially existing compatible resource management activities, are tempered by the fact that both population centers occur near the edge of the National Forest, adjacent to areas undergoing rapid urbanization. External, anthropogenically mediated threats are to be expected and may prove the most intractable management problem. In particular, increased fire frequency (as well as post-fire seeding of invasive non-native species), trampling, habitat damage by off-road vehicles (a particular concern at Elsinore Peak), and the concomitant invasion of the clay soil habitat by aggressive alien weeds, could each have serious negative effects on *Sibaropsis hammittii*. Among the potentially problematic alien species are *Avena barbata* Brot., *A. fatua* L., *Bromus hordeaceus* L., *B. madritensis* L. ssp. *rubens* (L.) Husnot, *Schismus barbatus* (L.) Thell., *Erodium cicutarium* (L.) L'Her., *E. botrys* (Cav.) Bertol., *E. brachycarpum* (Godron) Thell., *Centaurea melitensis* L., and *Brassica geniculata* (Desf.) J. Ball. These species are already present to varying degrees at sites occupied by *Sibaropsis*.

While formal legal protection for *Sibaropsis hammittii* (i.e., listing under state or federal Endangered Species Acts) seems unnecessary at the present time, future action would be warranted if downward trends in population size or vigor are noted.

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